

CHAPTER 1

INTRODUCTION

1-1. Purpose

The purpose of this publication is to provide guidance to engineering managers/planners for the commissioning of electrical systems at command, control, communications, computer, intelligence, surveillance, and reconnaissance (C4ISR) facilities. It specifically addresses different types of electrical power systems, the preparation of commissioning statements of work (SOW), specifications, and examples of commissioning tests that should be included during start-up. Electrical systems commissioning (sometimes referred to as "acceptance testing") on new projects is critical to ascertain that a system is installed correctly and that it will remain in service for its projected life cycle.

1-2. Scope

Guidance for commissioning of electric power systems on new projects is discussed in this manual. The systems addressed include the main power substation, standby generator, and uninterruptible power supply. The following areas are addressed: general commissioning criteria, commissioning plan, documentation requirements, verification procedures, system functional performance tests, deferred performance tests, corrective measures, acceptance documentation, post commissioning follow up procedures and examples of commissioning.

1-3 References

Appendix A contains a list of references used in this manual. Other pertinent literature may be substituted or used as supplements. Prescribed forms are also listed in appendix A.

1-4 General system testing requirements

The purpose of electric systems commissioning is to increase the reliability of electrical power systems after installation by identifying problems and providing a set of baseline values for comparison with subsequent routine tests. A procedure should be developed to include a planned approach (road map) of what should be done in order to verify the proper system installation. This procedure is the commissioning plan. Specific areas addressed in a commissioning plan include the verification of the installation of all equipment/components, interface connections between equipment and individual systems, and interconnection drawings. The development of this test plan specific to each system and/or component is key to the usefulness of any maintenance program. The plan consists of the schedule of when acceptance and routine tests should be performed, test forms to be used to record the outcome of the tests which are retained for comparison with previous and subsequent tests, and a listing of the required test devices. Since the results of the commissioning tests become baseline test values to compare with later tests and the results of the routine maintenance tests are compiled to identify any downward trend in performance, it is vital to the maintenance program to have accurate and complete records. To perform the testing, the plan lists all required tests in order of performance and gives a schedule for each test. The work items and schedule depend on many items including the importance and cost of the equipment, consequences of failure, age of equipment, past and future frequency of service, hours of operation, future maintenance availability, environmental conditions, and safety requirements.

1-5 Component testing

The reliability of any system is dependent on the interconnection of the equipment and the equipment itself. This manual's purpose is predominately for testing of electric systems themselves. It is assumed that the detailed and comprehensive individual testing of equipment has been completed before the commencing of commissioning of the system. However, general testing procedures for the components of the systems described in this manual are addressed in chapter 3. Commissioning requirements for the system components are typically provided with the original proposal for the procurement of the equipment. The requirements provided by the equipment manufacturer should be adhered to in addition to the recommended testing herein. Although there are many of different components to any electrical system, there are some tests that are common among the equipment. Examples of the common testing procedures include the assembly check, alignment check, grounding verification, insulation resistance tests and polarization index to name a few. These common tests are described in detail in chapter 2. Sufficient time should be allocated to define the inspections required, perform the check, and document the results. A review of the system drawings will show major pieces of equipment. Specific procedures should be developed for each test referencing the equipment to be used, drawings to be followed, and step by step procedures with readings to be recorded and forms for the results.

1-6 System commissioning testing

Electrical systems commissioning on new projects is critical to ascertain that a system is installed properly and that it will remain in service for its projected life cycle. The commissioning of a system encompasses the individual testing of the related components, the verification of the component interconnection against the drawings, and the functional testing of the system as a whole. An understanding of the equipment involved and the modes of operation for a system are essential to the development of the system commissioning plan. A survey of the equipment of the system and listing the equipment in order of importance and startup is the first step in developing the commissioning plan. The schedule of the tests and inspections is dependent on many aspects of the equipment such as its importance and cost, the frequency of service, hours of operation, environmental conditions, accessibility, and safety requirements. The inspection, testing, and startup plan is then developed in conjunction with this schedule with instructions and procedures for the test plan. Examples of systems testing are discussed in chapters 4, 5 and 6. DA Forms 7463-R through 7475-R are checklists designed to assist in these inspections and tests. They are found as reproducible forms at the end of this manual. Problems may arise during the testing of the equipment and systems. In order to identify and correct these problems, troubleshooting techniques should be developed. Checking of equipment such as fuses, lights, and breakers for continuity, equipment calibration and settings, and investigating for faulty equipment or connections should be the first troubleshooting steps. For all problems, the equipment and component manuals are consulted for troubleshooting directions. Examples of the possible causes to common problems are shown for each system in the chapters that follow.

1-7 Cost of commissioning

The cost of commissioning for an electrical system is dependent upon many factors including the system size, complexity and the level of reliability desired. New building construction, renovation of an existing building, or the modernization also will effect the cost of commissioning. Experience has shown that the initial commissioning cost is more than offset by increased system reliability and reduced operating costs. The cost for commissioning a new building can range from 0.5 to 1.5 percent of the total construction cost as shown in the table below. For an existing building the commissioning costs can range from three to five percent of the total operating costs.

Table 1-1. Costs of commissioning, new construction

Commissioning Scope	Cost
Entire building(HVAC, Controls, Electrical, Mechanical) Commissioning	0.5-1.5% of total construction cost
HVAC and Automated Control System Commissioning	1.5-2.5% of mechanical system cost
Electrical Systems Commissioning	1.0-1.5% of electrical system cost
Energy Efficiency Measures Commissioning	\$0.23-0.28 per square foot

Source: Portland Energy Conservation Incorporated/Building Commissioning Guide, US Department of Energy, 30 July 1998